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Part 4: Tolerances [PGD 20: Engineering Standards]



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भारतीय मानक
आई. एस. ओ. मीट्रिक समलम्बी पेंच चूड़ियां
भाग 4 छूटें
(दूसरा पुनरीक्षण)

Indian Standard
ISO METRIC TRAPEZOIDAL SCREW THREADS
PART 4 TOLERANCES
(*Second Revision*)

ICS 21.040.10

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BUREAU OF INDIAN STANDARDS
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NATIONAL FOREWORD

This Indian Standard (Part 4) (Second Revision) which is identical with ISO 2903 : 1993 'ISO metric trapezoidal screw threads — Tolerances', issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Engineering Standards Sectional Committee and approval of the Light Mechanical Engineering Division Council.

This standard was originally issued in 1973 and subsequently revised in 1988. The first revision was harmonized with ISO Standard by adopting ISO 2903 : 1977. This second revision has been taken up to align it with the latest version of ISO 2903, which has been technically revised in 1993.

The text of ISO Standard has been approved as suitable for publication as Indian Standard without deviations. In the adopted standard certain conventions are not identical to those used in Indian Standards; attention is especially drawn to the following:

- a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
- b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a full point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
ISO 965-1 ¹⁾	IS — (Part 1): — ISO general purpose metric screw threads — Tolerances: Part 1 Principle and basic data (<i>under preparation</i>)	Identical
ISO 2901 : 1993	IS 7008 (Part 1) : 1999 ISO metric trapezoidal screw threads: Part 1 Basic profile and maximum material profile (<i>second revision</i>)	do
ISO 2902 : 1977	IS 7008 (Part 2) : 1988 ISO metric trapezoidal screw threads: Part 2 Pitch diameter combination (<i>first revision</i>)	do
ISO 5408 : 1983	IS 10587 : 1983 Terminology for screw threads	Technically Equivalent

This standard (Part 4) covers the tolerances for ISO metric trapezoidal screw threads. The other parts covering various aspects of the ISO metric trapezoidal screw threads are given as under:

<i>IS No.</i>	<i>Title</i>
IS 7008 (Part 1) : 1999	ISO metric trapezoidal screw threads: Part 1 Basic profile and maximum material profile (<i>second revision</i>)

(Continued on third cover)

¹⁾ To be published (Revision of ISO 965-1 : 1980).

Indian Standard

ISO METRIC TRAPEZOIDAL SCREW THREADS

PART 4 TOLERANCES

(Second Revision)

1 Scope

This International Standard specifies a tolerance system for metric trapezoidal screw threads in accordance with ISO 2902. The tolerances refer to the basic profile ISO 2901.

The tolerance system does not apply to trapezoidal screw threads with special requirements on axial displacement, for example lead screws.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 965-1:1980, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data*.

ISO 2901:1993, *ISO metric trapezoidal screw threads — Basic profile and maximum material profiles*.

ISO 2902:1977, *ISO metric trapezoidal screw threads — General plan*.

ISO 5408:1983, *Cylindrical screw threads — Vocabulary*.

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 5408 apply.

4 Symbols

(See figures 1 to 4)

D_4	basic major diameter of nut thread, in millimetres
D_1	basic minor diameter of nut thread, in millimetres
D_2	basic pitch diameter of nut thread, in millimetres
d	basic major diameter of bolt thread, in millimetres
d_3	basic minor diameter of bolt thread, in millimetres
d_2	basic pitch diameter of bolt thread, in millimetres
P	pitch, in millimetres
P_h	lead, in millimetres
N	designation for thread engagement group "Normal"
L	designation for thread engagement group "Long"
l_N	thread engagement, in millimetres
T	tolerance, in micrometres
T_{D1}	} tolerances for D_1 , D_2 , d , d_3 , d_2 (for D_4 no tolerances are specified), in micrometres
T_{D2}	
T_d	
T_{d3}	
T_{d2}	
ei, EI	lower deviations (EI for nut threads is equal to zero), in micrometres
es, ES	upper deviations, in micrometres

5 Structure of the tolerance system

The system is based on the tolerance system for ISO general-purpose metric screw threads of ISO 965-1, completed with tolerance positions c and e , and with values for pitches above 6 mm.

The recommended tolerance classes are, however, not the same as those for ISO metric screw threads in ISO 965-1.

6 Tolerance grades

The following tolerance grades are established:

	Tolerance grades		
Minor diameter of nut threads D_1 :	4		
Major diameter of bolt threads d :	4		
Pitch diameter of nut threads D_2 :	7	8	9
Pitch diameter of bolt threads d_2 :	(6)	7	8 9
Minor diameter of bolt threads d_3 :	7	8	9

Tolerance grade 6 for the pitch diameter (d_2) of the bolt thread has been included only as a means to establish the pitch diameter tolerances of grades 7, 8 and 9. See 13.4.2.

The tolerance grade for the minor diameter (d_3) of the bolt thread is always the same as for the pitch diameter (d_2).

However, the values for T_{d3} and T_{d2} are not the same for a same grade because $T_{d3} = 1,25T_{d2} + |es|$.

7 Tolerance positions

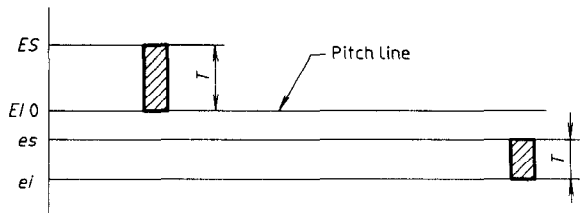


Figure 1 — Tolerance positions with respect to zero line (basic size)

The following tolerance positions are standardized for the pitch diameter.

- a) For nut threads: H with zero fundamental deviation (see figure 2 and table 1).
- b) For both threads: c and e with negative fundamental deviation (see figure 3 and table 1).

The tolerance position for the minor diameter D_1 and the major diameter D_4 of the nut threads is always H, i.e. with zero fundamental deviation. The tolerance position for the major diameter d and minor diameter d_3 of the bolt threads is in all cases h, i.e. with zero fundamental deviation, and it is independent of the tolerance position of the pitch diameter.

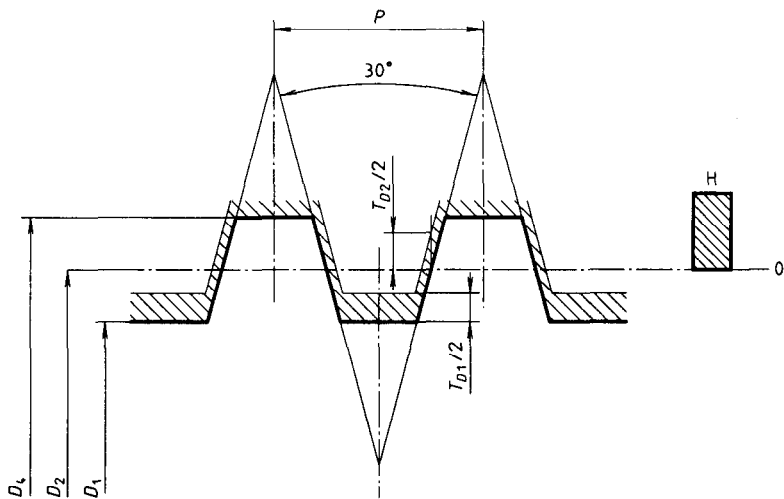


Figure 2 — Nut threads with tolerance position H for the pitch diameter

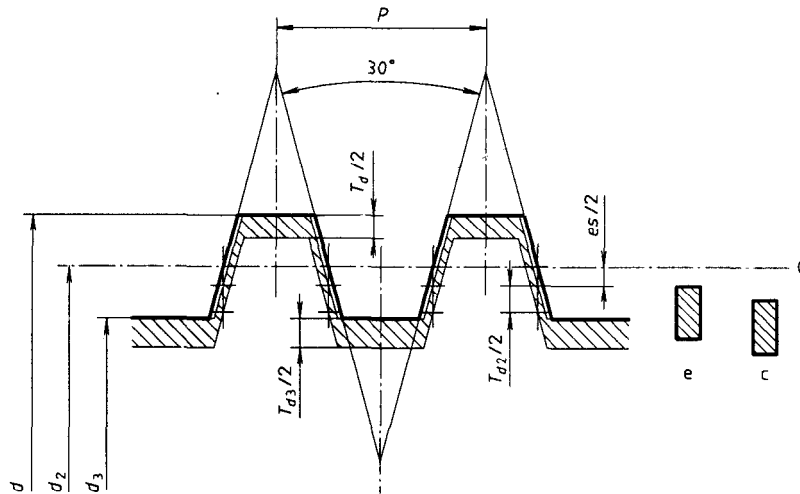


Figure 3 — Bolt threads with tolerance positions c and e for the pitch diameter

Table 1 — Fundamental deviations for the pitch diameter of nut threads and bolt threads

Pitch <i>P</i>	Fundamental deviation		
	Nut thread	Bolt thread	
	D_2	d_2	
	H <i>El</i>	c <i>es</i>	e <i>es</i>
mm	μm	μm	μm
1,5	0	-140	-67
2	0	-150	-71
3	0	-170	-85
4	0	-190	-95
5	0	-212	-106
6	0	-236	-118
7	0	-250	-125
8	0	-265	-132
9	0	-280	-140
10	0	-300	-150
12	0	-335	-160
14	0	-355	-180
16	0	-375	-190
18	0	-400	-200
20	0	-425	-212
22	0	-450	-224
24	0	-475	-236
28	0	-500	-250
32	0	-530	-265
36	0	-560	-280
40	0	-600	-300
44	0	-630	-315

8 Lengths of thread engagement

The length of thread engagement is classified into the groups N or L, in accordance with table 2.

9 Crest and root diameter tolerances

9.1 Minor diameter tolerances of nut thread (T_{D1})

For the minor diameter tolerance of the nut thread, T_{D1} , there is only one tolerance grade, 4 (see table 3).

9.2 Major diameter tolerances of bolt thread (T_d)

For the major diameter tolerance of the bolt thread, T_d , there is only one tolerance grade, 4 (see table 4).

9.3 Minor diameter tolerances of bolt thread (T_{d3})

For the minor diameter tolerance of the bolt thread, T_{d3} , there are three tolerance grades, 7, 8, and 9, in accordance with table 5.

10 Pitch diameter tolerances

For the pitch diameter tolerances there are three tolerance grades, 7, 8 and 9 for nut threads, in accordance with table 6, and four tolerance grades, 6, 7, 8 and 9 for bolt threads, in accordance with table 7.

Table 2 — Lengths of thread engagement

Dimensions in millimetres

Basic major diameter		Pitch <i>P</i>	Groups of lengths of thread engagement, <i>l</i>		
<i>d</i>			N		L
over	up to and incl.		over	up to and incl.	over
5,6	11,2	1,5	5	15	15
		2	6	19	19
		3	10	28	28
11,2	22,4	2	8	24	24
		3	11	32	32
		4	15	43	43
		5	18	53	53
		8	30	85	85
22,4	45	3	12	36	36
		5	21	63	63
		6	25	75	75
		7	30	85	85
		8	34	100	100
		10	42	125	125
		12	50	150	150
45	90	3	15	45	45
		4	19	56	56
		8	38	118	118
		9	43	132	132
		10	50	140	140
		12	60	170	170
		14	67	200	200
		16	75	236	236
		18	85	265	265
90	180	4	24	71	71
		6	36	106	106
		8	45	132	132
		12	67	200	200
		14	75	236	236
		16	90	265	265
		18	100	300	300
		20	112	335	335
		22	118	355	355
		24	132	400	400
28	150	450	450		
180	355	8	50	150	150
		12	75	224	224
		18	112	335	335
		20	125	375	375
		22	140	425	425
		24	150	450	450
		32	200	600	600
		36	224	670	670
		40	250	750	750
		44	280	850	850

Table 3 — Minor diameter tolerances of nut threads (T_{D1})

Pitch P	Tolerance grade 4
mm	μm
1,5	190
2	236
3	315
4	375
5	450
6	500
7	560
8	630
9	670
10	710
12	800
14	900
16	1 000
18	1 120
20	1 180
22	1 250
24	1 320
28	1 500
32	1 600
36	1 800
40	1 900
44	2 000

Table 4 — Major diameter tolerances of bolt threads (T_d)

Pitch P	Tolerance grade 4
mm	μm
1,5	150
2	180
3	236
4	300
5	335
6	375
7	425
8	450
9	500
10	530
12	600
14	670
16	710
18	800
20	850
22	900
24	950
28	1 060
32	1 120
36	1 250
40	1 320
44	1 400

Table 5 — Minor diameter tolerances of bolt thread (T_{d3})

Basic major diameter d		Pitch P	Tolerance position c of the pitch diameter tolerance			Tolerance position e of the pitch diameter tolerance		
over	up to		Tolerance grades			Tolerance grades		
			7	8	9	7	8	9
mm	mm	mm	μm	μm	μm	μm	μm	μm
5,6	11,2	1,5	352	405	471	279	332	398
		2	388	445	525	309	366	446
		3	435	501	589	350	416	504
11,2	22,4	2	400	462	544	321	383	465
		3	450	520	614	365	435	529
		4	521	609	690	426	514	595
		5	562	656	775	456	550	669
22,4	45	8	709	828	965	576	695	832
		3	482	564	670	397	479	585
		5	587	681	806	481	575	700
		6	655	767	899	537	649	781
		7	694	813	950	569	688	825
		8	734	859	1 015	601	726	882
		10	800	925	1 087	650	775	937
		12	866	998	1 223	691	823	1 048

Basic major diameter <i>d</i>		Pitch <i>P</i>	Tolerance position <i>c</i> of the pitch diameter tolerance			Tolerance position <i>e</i> of the pitch diameter tolerance		
over	up to		Tolerance grades			Tolerance grades		
			7	8	9	7	8	9
mm	mm	mm	μm	μm	μm	μm	μm	μm
45	90	3	501	589	701	416	504	616
		4	565	659	784	470	564	689
		8	765	890	1 052	632	757	919
		9	811	943	1 118	671	803	978
		10	831	963	1 138	681	813	988
		12	929	1 085	1 273	754	910	1 098
		14	970	1 142	1 355	805	967	1 180
		16	1 038	1 213	1 438	853	1 028	1 253
		18	1 100	1 288	1 525	900	1 088	1 320
90	180	4	584	690	815	489	595	720
		6	705	830	986	587	712	868
		8	796	928	1 103	663	795	970
		12	960	1 122	1 335	785	947	1 160
		14	1 018	1 193	1 418	843	1 018	1 243
		16	1 075	1 263	1 500	890	1 078	1 315
		18	1 150	1 338	1 588	950	1 138	1 388
		20	1 175	1 363	1 613	962	1 150	1 400
		22	1 232	1 450	1 700	1 011	1 224	1 474
180	355	24	1 313	1 538	1 800	1 074	1 299	1 561
		28	1 388	1 625	1 900	1 138	1 375	1 650
		8	828	965	1 153	695	832	1 020
		12	998	1 173	1 398	823	998	1 223
		18	1 187	1 400	1 650	987	1 200	1 450
		20	1 263	1 488	1 750	1 050	1 275	1 537
		22	1 288	1 513	1 775	1 062	1 287	1 549
		24	1 363	1 600	1 875	1 124	1 361	1 636
		32	1 530	1 780	2 092	1 265	1 515	1 827
		36	1 623	1 885	2 210	1 343	1 605	1 930
		40	1 663	1 925	2 250	1 363	1 625	1 950
		44	1 755	2 030	2 380	1 440	1 715	2 065

Table 6 — Pitch diameter tolerances of nut thread (T_{D2})

Basic major diameter <i>d</i>		Pitch <i>P</i>	Tolerance grades		
over	up to and incl.		7	8	9
mm	mm	mm	μm	μm	μm
5,6	11,2	1,5	224	280	355
		2	250	315	400
		3	280	355	450
11,2	22,4	2	265	335	425
		3	300	375	475
		4	355	450	560
		5	375	475	600
22,4	45	8	475	600	750
		3	335	425	530
		5	400	500	630
		6	450	560	710
		7	475	600	750
		8	500	630	800
		10	530	670	850
		12	560	710	900
45	90	3	355	450	560
		4	400	500	630
		8	530	670	850
		9	560	710	900
		10	560	710	900
		12	630	800	1 000
		14	670	850	1 060
		16	710	900	1 120
		18	750	950	1 180
90	180	4	425	530	670
		6	500	630	800
		8	560	710	900
		12	670	850	1 060
		14	710	900	1 120
		16	750	950	1 180
		18	800	1 000	1 250
		20	800	1 000	1 250
		22	850	1 060	1 320
180	355	24	900	1 120	1 400
		28	950	1 180	1 500
		8	600	750	950
		12	710	900	1 120
		18	850	1 060	1 320
		20	900	1 120	1 400
		22	900	1 120	1 400
		24	950	1 180	1 500
		32	1 060	1 320	1 700
		36	1 120	1 400	1 800
		40	1 120	1 400	1 800
		44	1 250	1 500	1 900

Table 7 — Pitch diameter tolerances of bolt thread (T_{d2})

Basic major diameter d		Pitch P	Tolerance grades			
over	up to and incl.		6	7	8	9
mm	mm	mm	μm	μm	μm	μm
5,6	11,2	1,5	132	170	212	265
		2	150	190	236	300
		3	170	212	265	335
11,2	22,4	2	160	200	250	315
		3	180	224	280	355
		4	212	265	335	425
		5	224	280	355	450
22,4	45	8	280	355	450	560
		3	200	250	315	400
		5	236	300	375	475
		6	265	335	425	530
		7	280	355	450	560
		8	300	375	475	600
		10	315	400	500	630
		12	335	425	530	670
45	90	3	212	265	335	425
		4	236	300	375	475
		8	315	400	500	630
		9	335	425	530	670
		10	335	425	530	670
		12	375	475	600	750
		14	400	500	630	800
		16	425	530	670	850
		18	450	560	710	900
90	180	4	250	315	400	500
		6	300	375	475	600
		8	335	425	530	670
		12	400	500	630	800
		14	425	530	670	850
		16	450	560	710	900
		18	475	600	750	950
		20	475	600	750	950
		22	500	630	800	1 000
		24	530	670	850	1 060
		28	560	710	900	1 120
180	355	8	355	450	560	710
		12	425	530	670	850
		18	500	630	800	1 000
		20	530	670	850	1 060
		22	530	670	850	1 060
		24	560	710	900	1 120
		32	630	800	1 000	1 250
		36	670	850	1 060	1 320
		40	670	850	1 060	1 320
		44	710	900	1 120	1 400

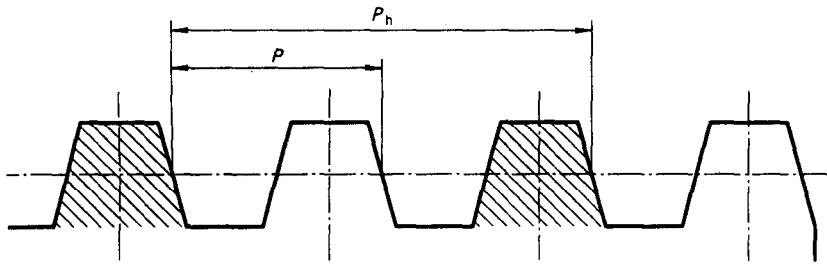


Figure 4 — Lead and pitch of multiple-start thread

11 Recommended tolerance classes

In order to reduce the number of gauges and tools, the tolerances should preferably be chosen from tables 8 and 9.

The following general rules can be formulated for the choice of tolerance quality.

- Medium: for general use.
- Coarse: for cases when manufacturing difficulties can arise.

If the actual length of thread engagement is unknown, group N is recommended.

Table 8 — Recommended tolerance classes for nut threads

Tolerance quality	Tolerances for the pitch diameter	
	N	L
Medium	7H	8H
Coarse	8H	9H

Table 9 — Recommended tolerance classes for bolt threads

Tolerance quality	Tolerances for the pitch diameter	
	N	L
Medium	7e	8e
Coarse	8c	9c

12 Multiple-start threads

The tolerances for multiple-start threads (see figure 4) are the same as for single-start threads, with the exception of the pitch diameter tolerances which are enlarged.

The tolerance values for T_{D2} and T_{d2} , specified in tables 6 and 7, shall, for multiple-start threads, be multiplied by a factor according to table 10.

Table 10 — Factors for multiple-start threads

Number of starts	2	3	4	5 and larger
Factor	1,12	1,25	1,4	1,6

13 Formulae

13.1 Fundamental deviations

The fundamental deviations for nut and bolt threads have been calculated according to the following formulae.

for $EI_H = 0$

$$es_c = -(125 + 11P) \text{ for } P \text{ up to and including } 2$$

$$es_c = -5 + 94,12\sqrt{P} \text{ for } P = 3 \text{ to } P = 44$$

$$es_e = -(50 + 11P) \text{ for } P \text{ up to and including } 3$$

$$es_e = -47,49\sqrt{P} \text{ for } P = 4 \text{ to } P = 44$$

13.2 Length of thread engagement

For the calculation of the limits of the normal length of thread engagements l_N in table 2, the following rule has been applied.

For each pitch within a certain diameter range, d has been set equal to the smallest diameter (within the range) which appears in table 2.

$$l_N \text{ min.} = 2,24Pd^{0,2}$$

$$l_N \text{ max.} = 6,7Pd^{0,2}$$

13.3 Crest diameter tolerances

13.3.1 Tolerances for minor diameter of nut thread (T_{D1})

The T_{D1} tolerances for grade 4 are calculated according to the following formula:

$$T_{D1} = 0,63 (230P^{0,7})$$

13.3.2 Tolerances for major diameter of bolt thread (T_d)

The T_d tolerances for grade 4 are calculated according to the following formula:

$$T_d = 0,63 \left(180 \sqrt[3]{P^2} - \frac{3,15}{\sqrt{P}} \right)$$

13.3.3 Tolerances for minor diameter of bolt thread (T_{d3})

The T_{d3} tolerances are obtained from the T_{d2} values according to the following formula:

$$T_{d3} = 1,25T_{d2} + [es]$$

13.4 Pitch diameter tolerances

13.4.1 Tolerances for pitch diameter of nut thread (T_{D2})

The T_{D2} tolerances are obtained from the tolerances for grade 6, T_{d2} (6), (see table 7) according to table 11.

Table 11 — Tolerances for pitch diameter of nut thread (T_{D2})

Tolerance grades		
7	8	9
$1,7T_{d2} (6)$	$2,12T_{d2} (6)$	$2,65T_{d2} (6)$

13.4.2 Tolerances for pitch diameter of bolt thread (T_{d2})

The T_{d2} tolerances are calculated according to the following formulae (d equal to the geometrical mean value of the diameter range limits):

$$T_{d2} (6) = 90P^{0,4} \times d^{0,1}$$

$$T_{d2} (7) = 1,25T_{d2} (6)$$

$$T_{d2} (8) = 1,6T_{d2} (6)$$

$$T_{d2} (9) = 2T_{d2} (6)$$

13.5 Rules of rounding

The values for pitch and crest diameter tolerances and for fundamental deviations have been calculated for the formulae above and then rounded off to the nearest value in the R40 series of preferred numbers.

The calculated values for the minor diameter tolerances T_{d3} have not been rounded.

14 Designation

A complete designation for a screw thread shall comprise a designation for the thread system and size, and a designation for the thread tolerance.

The thread designation shall be as given in ISO 2902.

The tolerance designation consists of a symbol for the pitch diameter tolerance only.

There is no need to designate the crest diameter tolerance since

- the tolerance position is always the same;
- only one tolerance grade is established for the minor diameter of nut threads (D_1) and for the major diameter of bolt threads (d).

Each tolerance designation shall comprise:

- a figure indicating the grade of the pitch diameter tolerance;
- a letter indicating the position of the pitch diameter tolerance, capital for nuts, small for bolts.

EXAMPLES

For nut threads:

$$\text{Tr } 40 \times 7 - 7\text{H}$$

For bolt threads:

$$\text{Tr } 40 \times 7 - 7\text{e}$$

For two-start, left-hand bolt threads:

$$\text{Tr } 40 \times 14 (\text{P7}) \text{ LH} - 7\text{e}$$

A fit between threaded parts is indicated by the nut thread tolerance designation followed by the bolt thread tolerance designation separated by a stroke.

EXAMPLES

$$\text{Tr } 40 \times 7 - 7\text{H}/7\text{e}$$

$$\text{Tr } 40 \times 14 (\text{P7}) - 7\text{H}/7\text{e}$$

(Continued from second cover)

<i>IS No.</i>	<i>Title</i>
IS 7008 (Part 2) : 1988	ISO metric trapezoidal screw threads: Part 2 Pitch diameter combination (<i>first revision</i>)
IS 7008 (Part 3) : 1988	ISO metric trapezoidal screw threads: Part 3 Basic dimensions (<i>first revision</i>)
IS 7684 : 1975	Limits of sizes for ISO metric trapezoidal nut threads (diameter range 8 to 100 mm)
IS 7685 : 1975	Limits of sizes for ISO metric trapezoidal bolts threads (diameter range 8 to 100 mm)
IS 7726 : 1975	Limits of sizes for ISO metric trapezoidal nut threads (diameter range 105 to 300 mm)
IS 7727 : 1975	Limits of sizes for ISO metric trapezoidal bolts threads (diameter range 105 to 300 mm)

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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Amendments Issued Since Publication

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